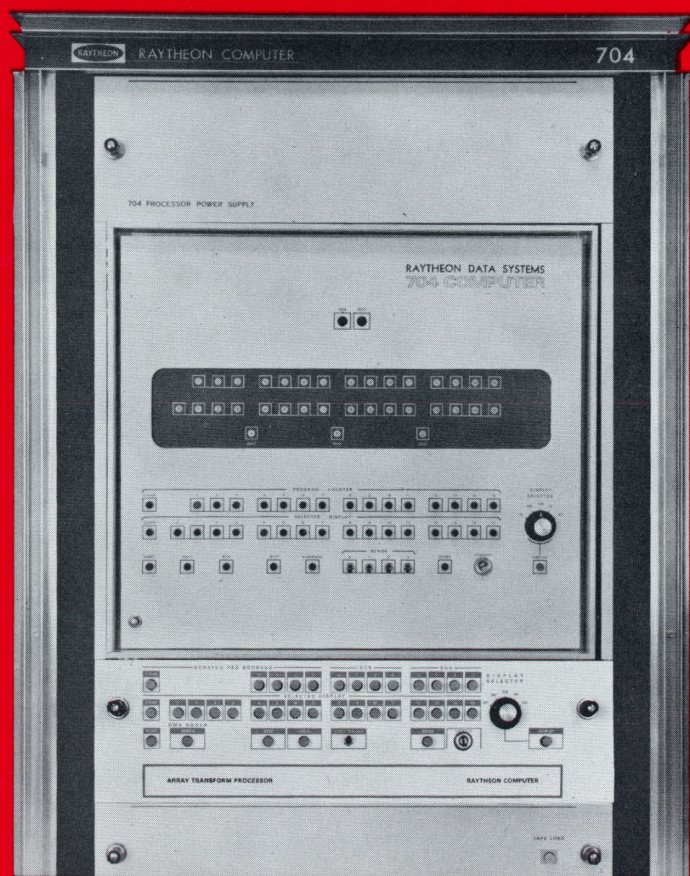




Array Transform Processor

FFT • FFTI • Complex Multiply
Convolution Integral • Clear
Complex Spectral Magnitude
Scan • Real Add/Subtract
Real Multiply • Array Move

Raytheon Data Systems

Raytheon Data Systems Array Transform Processor

Practical and inexpensive...

Raytheon Data Systems' Array Transform Processor has made high speed signal processing and analysis practical and inexpensive. The new ATP is an auxiliary processor of the Raytheon 700-Series computers that is ready to go to work on your problems immediately. And Raytheon Data Systems' ATP is the only true hardware array processor in the minicomputer field.

Raytheon Data Systems' ATP controls the flow of data arrays in performing highly iterative arithmetic processes encountered in operational calculus and linear algebra. Organization of the ATP allows indexed addressing to be specified for up to three data arrays which reside in the main memory of the central processor. Logically, these arrays may overlay areas of memory defined as buffer storage by the central processor program.

Processing data by logical sets of arrays greatly increases the efficiency of general purpose computer systems. It is particularly adaptable to highly repetitive operations normally performed by a program loop where the same sequence of instructions is fetched from storage a large number of times. Raytheon Data Systems' ATP hardware, however, is automatically controlled. Instruction fetches are not required during the process thereby conserving the associated memory access.

Raytheon Data Systems developed a special arithmetic-logic unit for the ATP which performs only the functions necessary for its particular class of processes. This unit features a higher level of performance and is more simply controlled than an equivalent general purpose arithmetic unit.

Powerful array processing...

Fast Fourier Transform & Inverse (FFT & FFTI) — Processing is performed with the Cooley-Tukey Algorithm using complex arithmetic.

Convolution Integral — Correlation and filtering processes.

Complex Multiply — Performed value for value (independently indexed) between arrays.

Complex Spectral Magnitude — Produces the sum of the squares of the real and imaginary parts of a complex number.

Clear — Sets storage locations to zero; indexing is permitted and allows interleaved locations to be cleared.

Real Multiply — Performed value for value (independently indexed) between arrays.

Read Add/Subtract — Performed value for value (independently indexed) between arrays.

Array Move — Relocates, converts, reorders, and translates arrays.

Scan — Determines either the largest positive or largest negative value in array.

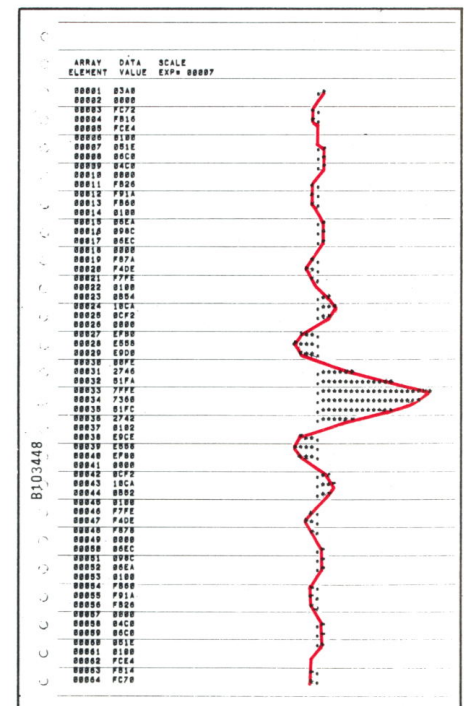
GP computer capability...

Raytheon Data Systems' 700 Series general purpose computers are 16-bit machines designed for on-line,

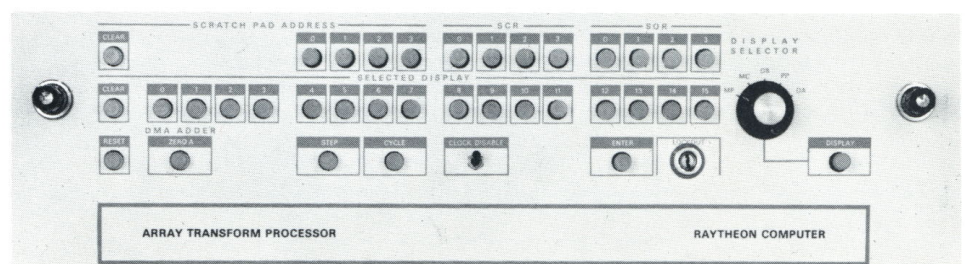
real-time applications. All the processors in the 700 Series are identical except for cycle times. So you can choose from a range of 900 ns, 1.0 μ s, or 1.75 μ s cycle times. Then if your requirements change, you can change the CPU without any software penalties. Programs written for one machine will run on any other machine with no changes. Because of this compatibility, whichever 700-Series processor you select, you can choose from Raytheon Data Systems' library of over 600 programs and subroutines.

```
: CLEAR      PRAY
DIMENSION   PRAY, 4 TRAY, 12 IRAY, 10 JRAY, 10
: CLEAR      JRAY
: CLEAR      JRAY
0           DO 2 (I)=1,128,2
1           MAKE IRAY(I),X7FFF
2           CONTINUE
3           FFT RINVERSE IRAY
4           MOVE SINGLE JRAY,1,1 IRAY,992,1 32
5           MOVE SINGLE JRAY,32,1 IRAY,1,1 32
6           NORMALIZE SINGLE JRAY
7           PLOT SEQUENTIAL JRAY,6 PHEX
8           STOP
```

Simple SPIEL program instructions to build a zero-phase low-pass digital filter.

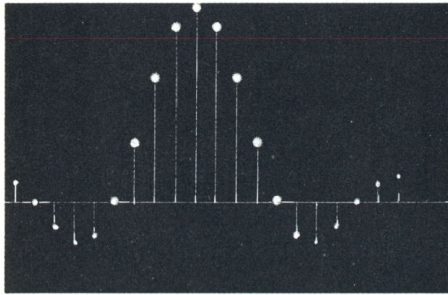


Printout from high speed line printer.

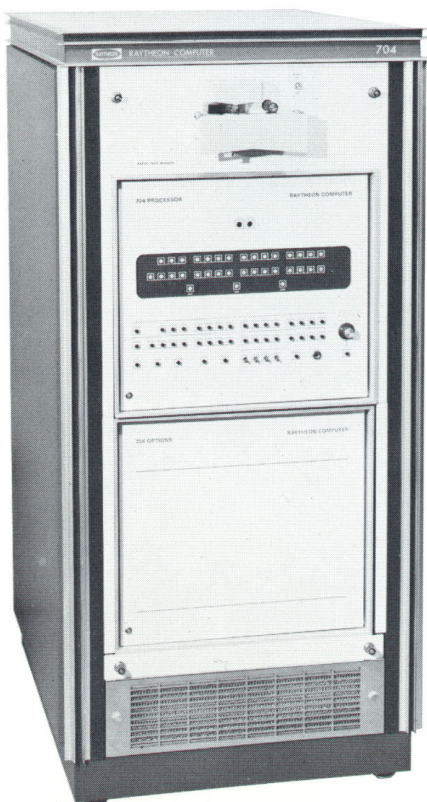


Go faster with our hardware...

Raytheon Data Systems' ATP is a true hardware array processor. Specifications for the ATP hardware are provided on the back page of this brochure. The ATP works with any Raytheon 700-Series computer to provide on-line, real-time signal processing and analysis. Complete with a Raytheon 704 general purpose computer, the ATP hardware costs about \$30,000. And you can use the computer for other tasks as well. You can preprocess FORTRAN IV programs for the 360 or do inventory control with our unique Sort/Merge and Report Generator programs.



Waveform photograph from oscilloscope.



Save money with our ATP Software Simulator...

Raytheon Data Systems has also developed an alternate system for those applications not requiring higher speed processing. For less than \$20,000, the system includes our powerful Raytheon 704 computer with 8K of core and a complete software package. I/O is done through a high speed reader and an ASR-33 terminal. Software for this system includes the ATP Simulator, the ATP Software Driver, and SPIEL (Signal Processing Interactive Engineering Language.)

ATP Simulator — The ATP Simulator accepts the same calls and performs identical operations to the ATP hardware with the exception that the hardware operates 20 to 100 times faster than the Simulator. ATP hardware may be added to a system at any time without altering the operational program other than to compensate for increased throughput.

ATP Software Driver — The ATP Software Driver allows the ATP to be interfaced to any one of Raytheon Data Systems' operating system I/O Monitors.

Signal Processing Interactive Engineering Language — With SPIEL, you can automatically compile and perform data acquisition, signal analysis, data display and logging. FORTRAN-like statements are entered directly from the teletype keyboard or from special control panels. The computer then executes the resultant interpretive program to solve the



problem and display the results. SPIEL interfaces to Conversational FORTRAN and assembly language programs.

Applications...

The combination of the ATP and Raytheon 700-Series gp computer is extremely flexible in a wide range of applications. These include communications, shock/vibration, geophysics, biomedical, acoustics, structural analysis, sonar, system testing and analysis, and many, many others.

A wide range of processing applications is available by modifying array addresses and index increments specified for the basic processes. Also, the ability to perform successive processes on a given data set permits a variety of complex operations with relatively simple control segments.

We supply the entire system...

Raytheon Data Systems is the only computer manufacturer that has all the equipment you need to do complete signal processing and analysis. Our systems-oriented engineers will work with you to determine your specific needs. Using an off-the-shelf systems approach, your system will then be installed and tested by Raytheon Data Systems. Working with a qualified, reliable single source supplier is your assurance that your system will be operational with minimal effort on your part.

There is complete compatibility in every Raytheon Data Systems processor, peripheral, interface, and software. Raytheon Data Systems' AID (Applications Interface Devices) concept offers instant interfaces for any application. We are also the only computer manufacturer that offers software support at machine language and FORTRAN levels for array type hardware. And Raytheon Data Systems can provide applications assistance and service your system from any of its worldwide service centers.

ATP Timing

All times are in milliseconds using 706 memory with cycle time of 0.9 microseconds. Hardware times are with ATP Software Driver. ATP Software Simulator times are with hardware multiply/divide.

FUNCTION	DATA POINTS											
	Hardware	Simulator	Hardware	Simulator	Hardware	Simulator	Hardware	Simulator	Hardware	Simulator	Hardware	Simulator
	256	256	512	512	1024	1024	2048	2048	4096	4096	8192	8192
FFT/FTTI												
Real	9.1	98	19.3	285	40.8	655	86.3	1435	184	3110	393	6730
Complex	13.5	232	30.9	538	66.3	1200	140	2690	311	5880	630	12100
Two Real	8.4	111	17.4	282	37.6	650	81	1370	176.5	3060	330	6500
CONVOLUTION (32-Point operator)	32	385	64	810	126	1630	245	3230	490	6450	940	12900
ADD/SUBTRACT (Including Normalization)												
Single-Single	3	14.3	5.6	27.2	10.6	56	20.7	110	39	214	75.6	435
Single-Double	3.5	—	6.8	—	13	—	24.8	—	47.2	—	92	—
Double-Double	4.1	—	8	—	15.5	—	28.9	—	55.4	—	100	—
ADD/SUBTRACT (Without Normalization)												
Single-Single	1.31	8	2.35	15.1	4.40	29.4	8	62	14.5	119	27.4	232
Single-Double	1.36	17.2	2.45	33.3	4.60	65.6	8.40	136	15.3	266	29	450
Double-Double	1.41	13.2	2.55	25.8	4.80	50.7	8.80	102	16.1	202	30.6	400
COMPLEX MULTIPLY	2.13	17.9	4.25	35.1	8.50	72	17	140	34	278	68	550
REAL MULTIPLY												
Single-Single	1.90	10.3	3.70	19.9	7.20	39	13.5	79	25.2	160	49.8	310
Single-Double	2.36	—	4.75	—	9.50	—	18.5	—	39	—	78	—
COMPLEX SPECTRAL MAGNITUDE	1.45	15.4	3.4	29	5.2	59	7.8	115	12.0	229	18.0	400

Specifications

Classification	Peripheral device to 700-Series Computer
Communication	Direct Memory access to Computer Memory
Functions	Fast-Fourier Transform (FFT) Fast-Fourier Transform Inverse (FTTI) Convolution Integral (CI) Complex Multiply (CM) Complex Spectral Magnitude (CSM) Clear (CL) Real Multiply (RM) Real Add (RA) Real Subtract (RS) Array Move and Convert (MV) Exchange or Translate (EXTR) Scan for Maximum/Minimum Value (SCN)
Subfunctions	Real Scale, Real Square Clear Indexed Values Add Constant, Subtract Constant Average Trace Sequential Array Average Multiplexed, Frame Sequential Array Cross Correlation, Auto Correlation Multiplexing, Demultiplexing
Indexing	Single, Double and Triple Precision
Computer I/O Control	Direct Output (DOT)
Instructions	Direct Input (DIN)
Memory Control Table	10 Core Memory Words

CORE REQUIREMENTS FOR FFT (include Driver and theta table)						
DATA POINTS	REAL ONLY		TWO REAL		COMPLEX	
	Hardware	Simulator	Hardware	Simulator	Hardware	Simulator
256	4K	4K	4K	4K	4K	4K
512	4K	4K	4K	4K	4K	4K
1024	4K	4K	8K	8K	8K	8K
2048	8K	8K	12K	8K	12K	8K
4096	12K	8K	16K	12K	16K	12K
8192	16K	12K	28K	24K	28K	24K
16384	28K	24K	—	—	—	—

Word Formats Single Precision, 16 bits
Double Precision, 31 bits
Triple Precision, 46 bits

Array Formats Single Precision Real
Complex (Real, Imaginary)
Double Precision Real
Triple Precision Real (Convolution Output Only)

Power 115 VAC, 60 Hz, 6 amps

Dimensions 5.25" x 19.0" x 26.0"

Weight 25 lbs.

Hardware Registers Multiplier, Multiplicand, Partial Product, Word Count, Auxiliary Address, Data, Scratch Pad Storage, DMA Address, Output Address, Input Address

RAYTHEON

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